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Sent: 12/12/2017 6:48:20 PM
To: Clark, Jacqueline [clark.jacqueline@epa.gov]
Subject: RE: DuPont data need

Jacquie,

Attached is a section dealing with air modeling at the Washington Works facility conducted in 2003 and 2004. I will continue to search the several hundred pages of DuPont studies and send you anything else I can find.

Roger

5.1 Air Modeling/Monitoring Comparison

5.1.1 Phase I Monitoring

Phase I air monitoring was conducted at the Site fence line from November 2003 to March 2004. Two sampling methods were used: OSHA Versatile Sampling (OVS) tubes and High-Volume Impactor samplers. Methods and results for these sampling programs were summarized in a 2006 publication, which is included in Appendix 5.1. Phase I monitoring was important for demonstrating robust sampling methods and establishing baseline concentrations, but the effort was limited in scope, and detection limits have since been improved.

5.1.2 Phase II Monitoring

Phase II monitoring was conducted from August to October 2005, and consisted of sampling ambient air (including particle size distributions) and rain. Sampling methods were the same as methods used in Phase I. Figure 5.1 provides the air sampling locations as well as the locations for other multimedia sampling discussed in the sections that follow. Table 5.1 provides a list of the multimedia sampling conducted at each location during Phase II. Tables 5.2 and 5.3 provide PFOA results for OSHA Versatile Sampling (OVS) tubes and High-Volume Impactor samplers, respectively. Table 5.4 provides a summary of rain data collected during one sampling event. Table 5.5 provides an average particle size distribution averaged over all sampling events at each sampling location.

5.1.3 Summary of Observations

Results for samples collected within a 2-mile radius of the Site during nine events, showed that all concentrations within a 2-mile radius ranged from non-detect to 75.9 ng/m³ (4.5 ppt). A summary of the average results from Phase II sampling is shown in Figure 5.2. The maximum concentrations in all nine sampling events were located at the northeast Site fence line, which corresponds with the long-term prevailing wind direction (winds from the southwest that blow toward the northeast). Air concentrations tend to decrease with distance from the Site in all directions except in the northeast quadrant where there is a slight increase at the 2-mile monitoring station. This increase cannot be explained definitively, but may be a result of terrain issues since this point is elevated and closer to the plume centerline, or an undetected source (other than Washington Works).

Rain data were collected during one event, and results are summarized in Figure 5.3. These results are aligned with the predominant wind direction for the day of sampling, which showed a significant wind out of the southeast that directed the plume toward the northwest. This wind pattern accounts for the higher rain concentration in the northwest quadrant. Results confirm the presence of PFOA in rain near the site and suggest the importance of wet deposition as a transport mechanism near the manufacturing area.

Because OVS tubes captured virtually no vapor phase material during nine sampling events, it is concluded that PFOA in air is primarily associated with particles. Particle size data in Table 5.5 show that the median diameter

size is less than 1 micron. This size range is aligned with the theory that PFOA emissions are particulate formed from hot vapors that immediately cool and condense when released to ambient air, and subsequently coagulate to form submicron sized particles. Physical evidence for this description of emissions formation can be seen in the example particle size distribution graph from Station 7, shown in Figure 5.4. The first peak in the curve indicates hot vapor condensation; the second peak indicates coagulation to form submicron particles. The mean particle size is 0.7 μm , which is in the expected size range for this mechanism of particle formation. The field data collected in Phase II can be used to draw conclusions about potential transport mechanisms of interest at the Site. Results show relatively small amounts (parts per quadrillion to parts per trillion levels) of PFOA in ambient air, such that air is an unlikely reservoir for this material; instead, air acts as a conduit to transport PFOA to other compartments. Because PFOA is predominantly particle associated and because it is measured in rain, it is theorized that deposition near the Site is an important mechanism for transporting PFOA from air to the earth. This theory is supported by comparing groundwater and ambient air data, with the understanding that air data represent a much smaller time period. Both groundwater and air show elevated concentrations at the Site fence line and at Station 6, the farthest point to the northeast of the site. (While the origin of these elevated concentrations at Station 6 is difficult to explain, the sampling and analytical quality have been reviewed such that results are accurate.) In addition, both groundwater and air concentrations within a 2-mile radius produced a decreasing trend with distance from the site in all quadrants except the northeast. (Note that groundwater concentrations decrease beyond the 2-mile radius in the northeast quadrant.). The data suggest a relationship between deposition from air and resulting groundwater concentrations. This theory was explored further in the Deposition Modeling Study, discussed in the following sections.

5.1.4 Air Modeling Studies

Modeling/Monitoring Comparison Study

DuPont conducted the two-phased Comparison Study to compare results from two air dispersion models, ISCST3-PRIME (hereafter ISC) and the American Meteorological

Society/Environmental Protection Agency Regulatory Model (AERMOD), to ambient air sampling data. The objective of this Comparison Study was to understand how modeling predictions relate to measured ambient air concentrations of PFOA. The Air

Modeling/Monitoring Comparison Study was not intended as a validation of either ISC or AERMOD, which would be a far more involved study requiring substantially more data.

Rather, this study was a less formal comparison between measured and modeled data. The two steady state plume models were chosen for comparison because these are models typically used to predict near-field ambient air concentrations resulting from emission of non-reactive pollutants to air from manufacturing facilities. Specifically, DuPont evaluated the following objectives:

- ⑨ How predictions from ISC compare with monitored values
- ⑨ How predictions from AERMOD compare with monitored values

The Air Modeling/Monitoring Comparison Study is included in Appendix 5.2.

Deposition Modeling Study

An additional evaluation was performed to test the ability of AERMOD to predict deposition flux of PFOA. This evaluation was performed by comparing predicted soil/grass concentrations that would result from modeled flux with actual soil/grass concentrations that were collected off-site during multimedia sampling in Phase II. A description of this study is included in a draft publication, included in Appendix 5.3.

5.1.5 Summary of Observations

Results of Modeling/Monitoring Comparison Study

The following conclusions were reached:

- ⑨ The performance of each model can be summarized by categorizing model results as over-predictions, under-predictions, or close approximations. Ninety modeled runs were conducted with the following results.

- For AERMOD, at least 85% of the predictions were either close approximations or over-predictions. Only 15% or less of the predictions underestimated monitored values. Because underprediction is an undesirable result in air dispersion modeling, AERMOD's performance was good.
 - The ISC model under-predicted the monitored value approximately half the time. Most of these under-predictions may originate from ISC's default assumption that ground level concentrations are zero when the height of the plume centerline exceeds the mixing height.
- ⑨ Of the two models, AERMOD was a better predictor than ISC:
- The Comparison Study showed that AERMOD outperforms ISC by demonstrating less error through bias and scatter and generating conservative values that were closer to monitored values.
 - The use of on-site or off-site meteorological data did not change this result.
 - The reason for the better performance is likely due to the improved algorithms in AERMOD that better represent turbulent conditions and terrain influences.
- ⑨ AERMOD provides conservative ambient air predictions of PFOA near a manufacturing facility that are useful for permitting or assessment purposes:
- AERMOD predictions accurately reflect maximum and minimum trends in the study area. Results were aligned with monitoring results that showed the maximum PFOA air concentrations typically occurred at or near the facility fence line and minimum values were most likely to occur at sampling stations farthest from the site, in the upwind direction from prevailing winds.
 - AERMOD errs on the conservative side, which is preferred to underpredicting actual values. The conservative nature of the predictions is expected and is a result of the short averaging time (24 hours) used for predictions plus variability and uncertainty in meteorological inputs. Conservatism in modeled values lends an added safety factor in community exposure assessments and in assessing compliance with permit values.
 - The degree of over prediction demonstrated in this Comparison Study is not unexpected. Various studies suggest over predictions up to 10X are not unusual when comparing modeling and monitoring values that are not in the same exact location, but are in the same general study area, and are collected over long periods of time. The comparison in this study was much more exact in that the modeled results were compared with monitored results collected at the same location and over a short time period.

The ISC model (including previous versions such as ISCST and ISCST2) has been EPA's recommended model for air dispersion modeling since the 1980s. As of November 9, 2006, EPA moved to AERMOD as its recommended model for air dispersion applications. Based on results from this comparison study, the use of AERMOD will prove beneficial to the Washington Works Site for providing more representative ambient air predictions.

Results of Deposition Study

Wet and dry deposition are hypothesized to be important mechanisms for removing airborne PFOA and transferring it to the earth's surface where it can adsorb to surface soil and vegetation and also migrate to subsurface soil and groundwater. Empirical data suggest that deposition is important and that air and groundwater concentrations have similar trends. A deposition study was undertaken to show that deposition can also account for concentrations of PFOA found in surface soil and grass. Because the modeling/monitoring study showed that AERMOD is a reasonable predictor of air concentrations, AERMOD was used to predict deposition flux and to correlate deposition with expected soil/grass concentrations. A comparison was made to see whether measured concentrations of soil/grass agreed with predicted concentrations that are based on deposition.

Results from the study are summarized in Table 5.6 and depicted in Figure 5.5. Predicted concentrations from modeled deposition were rounded and presented as contours of equal concentration (isopleths) in Figure 5.5. Approximately 40 off-site surface soil/grass samples from 17 locations were available for comparison with predicted values. Sample results are shown in Figure 5.5 in ranges of lower (≤ 10 ppb), medium (>10 to 30 ppb) and higher (>30 ppb) concentrations. The following observations were made;

- ⑨ There was reasonable agreement in the range of observed and predicted values across the 2 mile study area. Observed values ranged from <5 to 120 ppb. Predicted values from the Site fence line up to 2 miles ranged from <2 ppb to 360 ppb.
- ⑨ AERMOD predictions within 1 to 2 miles of the Site were in excellent agreement with observed soil/grass concentrations. *Average* observed results were in good agreement with predicted predictions concentrations at distances closer to the site, from approximately ¼ mile to 1 mile. However, *individual* sample results were an order of magnitude higher than predicted results in some cases – specifically for sample locations closest to the site in the southeast quadrant.
- ⑨ Predicted surface soil/grass concentrations in the northeast, northwest, and southwest quadrants are in excellent agreement with observed concentrations. However, observed results in the southeast quadrant are not as well correlated and are up to an order of magnitude higher than predicted results.

The fact that surface soil/grass concentrations resulting from modeled deposition flux were reasonably well aligned with sampling results suggests that deposition from air to the earth's surface can be explained by wet and dry deposition of air emissions. This finding provides further support that deposition is a key transport pathway near the Site. This study also concluded that AERMOD is a reasonably good predictor of deposition as well as ambient air concentrations.

5.1.6 Air Data Utilized in the Screening Level Exposure Assessment

All PFOA data for air and rain samples described above were provided to ENVIRON for the SLEA. The Phase I air monitoring results were not included in the exposure assessment because Phase I data were limited in scope and because analytical methods were improved to lower detection limits for Phase II. The air results collected during Phase II were utilized in the SLEA. In Table 5.7, data utilized in the SLEA are summarized by exposure areas within the three public drinking-water service districts located within two miles of the Site and the Local Landfill. The summary of air data in this table includes the number of sampling locations, number of samples per location, and the minimum and maximum PFOA concentrations in each exposure area. Figure 5.6 provides the locations of the exposure area as defined by ENVIRON for the SLEA.

Details as to how these air data were utilized in the SLEA are provided in the SLEA.

In addition to measured air data, the SLEA relied on annual average ambient air modeling data to evaluate potential variability in air concentrations over time and to address spatial gaps in air monitoring data. A report describing the methods and results of the modeling used in the SLEA is included in Appendix 5.4.

From: Clark, Jacqueline

Sent: Tuesday, December 12, 2017 12:19 PM

To: Reinhart, Roger <Reinhart.Roger@epa.gov>

Cc: Wilson, Jennifer <wilson.jenniferA@epa.gov>; Duchovnay, Andrew <Duchovnay.Andrew@epa.gov>

Subject: DuPont data need

Hi Roger- do you have, and can you send me the DuPont air modeling report? I've pulled the 2008 Environ report we included in our 2017 AR, but I need the modeling referred to in that report. Our air division needs the information as soon as possible. Thanks-Jacquie

Jacqueline Clark

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